Approach of natural environment preservation in Japanese Expressways

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ABSTRACT

Construction of the Expressways might disappear or reduce a habitat and growing place of the flora and fauna around there. In addition, the development might divide animal's migration pathway and bring the quality change of habitat and growing environment. Appropriate consideration would be crucial to avoid and decrease the influence above.

Therefore, when expressways in Japan are constructed, less influence on regional ecosystem is considered to create a new habitat and space of growth for natural environment.

Promotion of such road development leads to the maintenance of the preservation of the natural environment and biodiversity.

For example, bridge and tunnel structures have been planned and applied as appropriate to avoid the influence. As well as over pass and culvert box have been constructed to create pathway for animals. Moreover space generated in interchange loop is also developed with considering the flora and fauna around there.

In this report actual attempts exemplified above would be introduced for the future sustainable development of expressways in other countries.

1. INTRODUCTION

Approximately 70% of the land of Japan belongs to mountainous areas, and half of the population is concentrated on only 14% plains being scattered throughout the country. The Expressway network in Japan with a total length of 7,600km has been so far in operation from Hokkaido, the country's northern part throughout to Okinawa, the southern part.

Because the network in operation runs 2,000km in length from north to south, it is exposed to subarctic and subtropics areas. Due to many mountains across the country, the nationwide trunk network inevitably passes those mountainous areas. Moreover since two thirds of the land is classified into forests, the network passes natural environmental regions.

In case there is a habitat of valuable flora and fauna in the planned construction site in the Expressway, the habitat is avoided as much as possible, and the modifications of the topography and

environment were minimized with bridge and tunnel. In case it is unavoidable to build expressways across natural environmental areas, habitat of flora and fauna is transplanted newly in another place. Therefore much effort has been made for protection of the natural environmental protection and the goodness for habitats.

2. IMPACT OF CONSTRUCTING EXPRESSWAY ON ENVIRONMENT

Constructions of expressway make a great contribution for human livings, such as to strengthening, urban development, domestic economy, and shortening of travel time. Moreover, because fuel consumption in the expressway is less than that in national highway for the same run, the gross emission of CO_2 is decreased. Therefore, progress of expressway network has a meaningful construction in viewing for global environment.

But then, construction of expressway is concerned about negative impact on environment, the change in the environment around the expressway with the filling or cutting ground, and the influence of the loss of the native habitat of flora and fauna.

The impact of natural environment in constructing expressway is summarized in table 1.

Table 1. Impact of constructing expressway on environment

Classification	Direct influence	Indirect influence
Big mammal, Birds	Decrease in habitat. Dividing into parts of migration pathway. Lost of nesting place.	Collision with automobile Change in habitat
Small mammal, Reptilian and Amphibian	Lost of habitat. Dividing into parts of migration pathway.	Collision with automobile Isolation of local population.
Fish and shellfish	Dividing into parts according to changing river cross section.	Decrease in spawning ground by changing stream bed. Decrease in natural medium according to water quality change.
Plants	Decrease or change in habitat.	Change in vegetation caused by increase of sunlight to soil surface and decrease of soil moisture condition.

Construction of the expressway across the forest changes condition of sunlight because of deforesting many trees. The increase of sunlight duration might cause simplification of the ecosystem with progress of dryness around road, change in vegetation and moisture balance; some weak species to die out.

Cut slope if remained is also concerned about pioneer plants the coming of like Japanese pampas grass (*Miscanthus sinensis*) and denizen like Desert false indigo (*Amorpha fruticosa*).

Another influence on animals, noise and vibration from construction machine make raptor abandon nest, vehicle's head lights make firefly retard breeding. A new environmental condition brings large impact for the wildlife. Moreover, cars run over animals in crossing roads because segmented habitat is a serious problem for not only the animals but also drivers.

Another influence on fishes and shellfishes is the fear of disturbance to them, decrease in spawning ground, because of drastic change in the habitat, such as outflow of soil and sand, changing quality of water, and changing stream formation according to construction of the road.

Natural environment is to be considered at planning stage of expressway construction to solve the above problems. This consideration can be divided roughly into three kinds as shown in Table 2. Moreover, there is a concept "Creation" that maintains a new natural space as other consideration, too.

Table 2. The priority of natural environment conservation

Priority	Keyword	Content	The main technique
1	Avoid	An important part in the natural environment maintenance is avoided and the route is selected	Shift of route
2	Minimize	The influence that the road exerts on natural environment is reduced as much as possible.	Tunnel, bridge, slope vegetation and artificial animal path
3	Compensate	When important growth and the native habitat of the living thing are lost, an equal environment is maintained to the vicinity.	Biotope in road-maintenance of roadside wetland or afforest in embankment

This is an idea of the mitigation of Japan, and a specific strategy to consider to natural environment in the road construction. The case introduces in this paper is the one belonging to either category of minimize, compensate in Table 2 or the creation.

3. MINIMIZE BY CHANGE OF STRUCTURE

The first case is a technique to reduce the influence that the expressway construction gives natural environment as much as possible.

The Lake Poroto is in the South of Hokkaido (Figure 1), and the south side of the lake is only 1km far from the Pacific Ocean. On northern side of the lake, natural forests and artificial forests are spread.

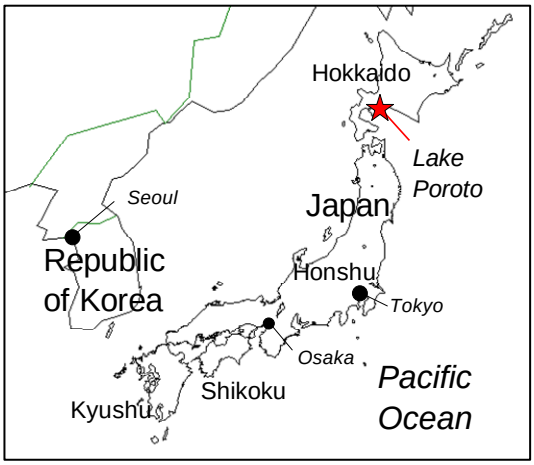

Fig.1 The location of Lake Poroto

The area is spread out approximately 400ha, therefore this area has been appointed sanctuary for animals and birds; brown bear (Ursus arctos), Ezoshika (Cervus nippon yesoensis), Ezo red fox (Vulpes vulpes schrencki), Raccoon dog (Nyctereutes procyonides albus), Russian flying squirrel (Pteromys volans orii), and about eighty species of birds such as the great spotted woodpecker (Dendrocopos major), blue-and-white flycatchers (Cyanoptila cyanomelana), Japanese Thrush (Turdus cardis). The Lake Poroto and the upper forest have been appointed “Poroto natural recreation forests” since 1976. Many marshes are formed in the forest by some gradual flows, and there are Japanese skunk-cabbage colonies on parts in the forest.

Because the Hokkaido Expressway was planed through this Poroto natural recreation forest, it was necessary to preserve the natural forest, the marsh, and the Japanese skunk-cabbage colony. Then, Poroto Bridge was planned to minimize deforestation and modification of the flow. Then wood were planned to cut only for the road width. Change of road structure from banking to bridge was also planned, so that animals never wander in the Expressway.

Fig.2 A brook in recreation forest

Fig.3 Poroto Bridge

The Hokkaido Expressway has been opened for 25 years. The Japanese skunk-cabbage colony along Poroto Bridge is grown. And habitat of Japanese skunk-cabbage has expanded wider to than at the time of construction. Quite a few tourists enjoy Japanese skunk-cabbage colonies along the esplanades during May.

Another case is the Nikko-Utsunomiya Expressway at Nikko city in Middle of Honshu. (Figure 4)

Nikko is a tourist town where Toshogu shrine and Lake Chuzenji are famous because the shrine was registered as World Heritage in 1999. This road was planned to pass the Nikko national park district, and had to minimize of the environmental impact. In Mt. Nakimushi district was constructed with not by cutting woods but

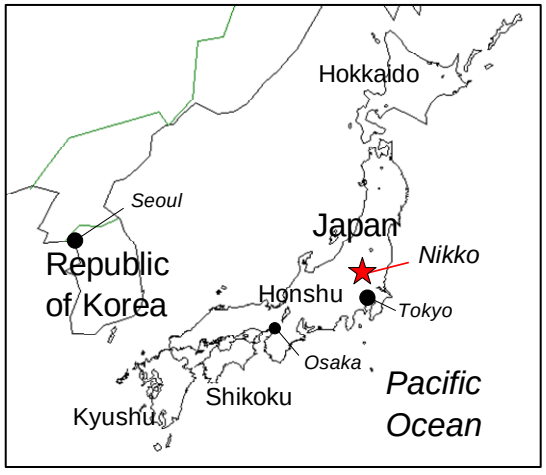

Fig. 4 The location of Nikko

constructing a tunnel and bridge, because of reduction of geographical modification. Fig. 5 is the pithead in the Nakimushiyama Tunnel. If it made it to the cutting ground structure, geographical features were modified like the short dashed line in Fig. 5. This method was very effective not only for natural environment but also landscaping. In this connection, the result of investigating the change in bird species number, from before constructing the road to 20 years later of use is a graph of Fig.6. It will be understood to have recovered to almost the same level before it uses it in 15 years though the number of forest birds decreased temporarily compared with before from this graph. Continuous research of monitoring shows that the mentioned above lead to birds species recovery after 15 years from construction. (Fig.6)

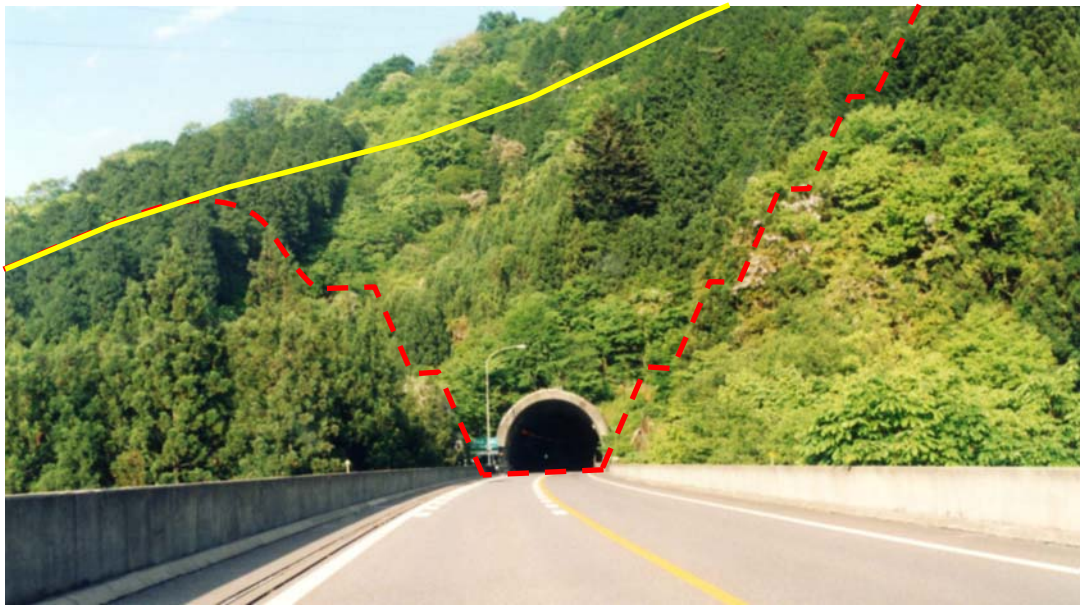

Fig.5　Nakimushiyama Tunnel (Nikko-Utsunomiya Expressway)

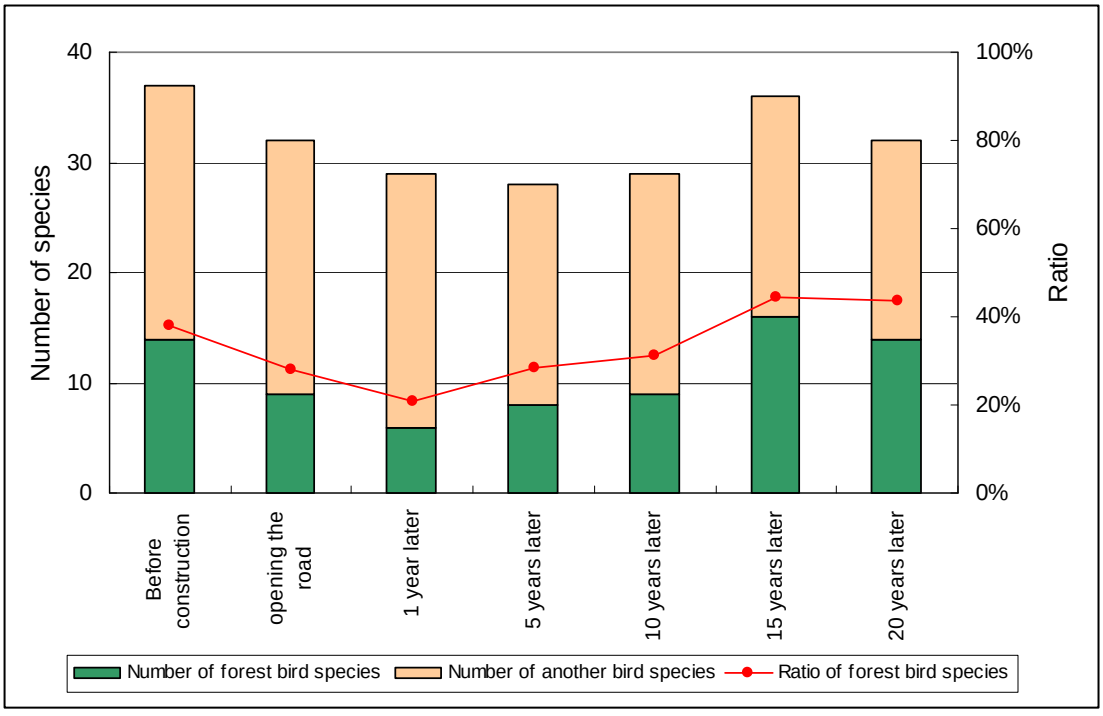

Fig.6　Recovery of bird species living in forest

4. COMPENSATE BY TRANSFER OF HABITAT

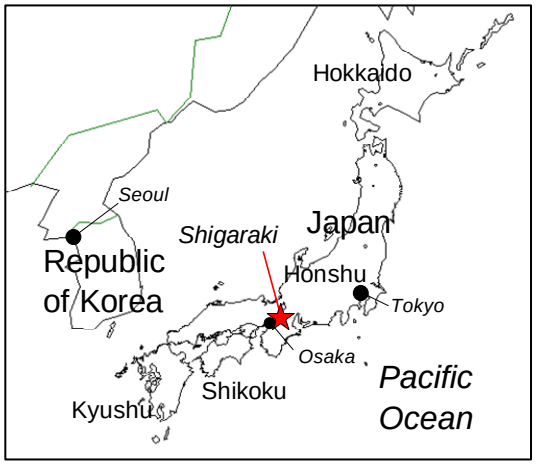

Fig.7 The location of Shigaraki

The first case is a technique of the putting substitution of a river and the transfer of vegetation on Shin-meishin Expressway.

The vicinity of Shigaraki interchange of Shin-meishin Expressway is specified as Shiga Prefectural Nature Park [1]. And the expressway, a national road, river and a railway go side by side a gradual mountainous district. The nature trail is maintained along the River Hayato. The transfer of a nature trail with its length of approximately 1km was needed for road construction. Therefore, the construction was done for the sake of preservation of natural environment and restoration of landscape as soon as possible. Many rocks were arranged in the riverbed at regular intervals like the weir to deposit soil and sand, and to bring a several flow pattern in the river route along to the natural trail. Figure 8 and Figure 9 are photographs after five years constructing in established of reed (Phragmites japonica) in the river channel of weeping love grass (Eragrostis curvula) besides hygrophytes such as the Common cattail (Typha latifolia), narrowleaf cattail (Typha angustifolia), and curlytop knotweed (Persicaria lapathifolia), “Himejiso”; belong among the perilla, and Japanese mugwort (Artemisa princeps) as the start, and restorations of various vegetation. Moreover, the small fishes about 5cm in length were able also to be found there.

Fig. 8-9 the view of the Hayato-River after 5 years from construction work

The cut out cubic block of the topsoil was transplanted on embankment along the river channel. It is excellent to transplant herbs with topsoil. The topsoil never flows because the block wholly contains plant roots.

Moreover, the most profitable advantage is that the seed of the plant that has grown originally in this district are mixed with potential in topsoil. The plant of a regional origin germinates after transfer

of cubic blocks. That is more early restoration of vegetation than seeding a uniform kind of vegetation. Figure.10 is photo of restoration vegetation 5 years after transplants. It recovered as vegetation to which diversity in plants was abundant, and a lot of infant Japanese red pine (Pinus densiflora) that had come flying from the vicinity did germinate.

In a conventional landscape gardening constructions of constructors used to plant buy seeds and seedlings. So, the individuals that have not succeeded to peculiar DNA of various places enters, and the disturbance of DNA is caused. In order to avoid this problem, in the development construction that NEXCO does, the seeds of trees in the location of development are gathered as much as possible before construction. And the gathered seedlings to be planted during construction. DNA can be prevented from on being disturbed by such an approach. Planting in this way by the seedling in the region promoted only for the road bank is done.

Fig. 10 The early recovered vegetation with topsoil transplant

Next case of compensation is maintenance of the Marsh Hiigo-ike on the Okayama Expressway. That is a marsh of approximately 1ha, in the Soja city , Okayama Prefecture. There is the growing place of a rare plant such as White egret flower (Pecteilis radiata) that categorized into “Near Threatened” by red list of the Ministry of the Environment [2]. Moreover, it is a habitat of a rare insect such as scarlet dwarf (Nannophya pygmaea), one of the smallest dragonflies in the world, “Ogumasanae” (Trigomphus ogumai) categorized into “Vulnerable”, and “Futasujisanae” (Trigomphus interruptus) categorized into NT.

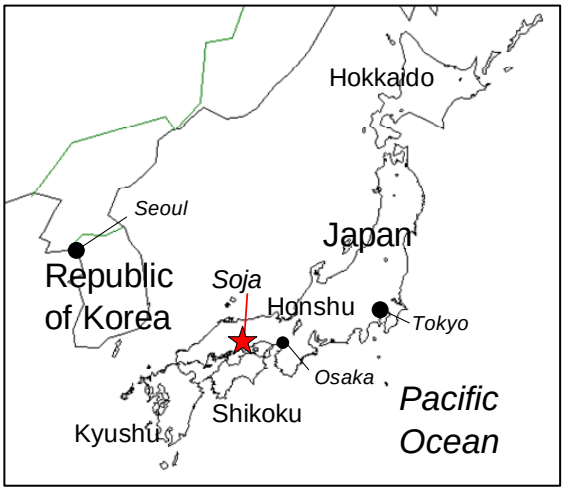

Fig.11 The location of Soja City

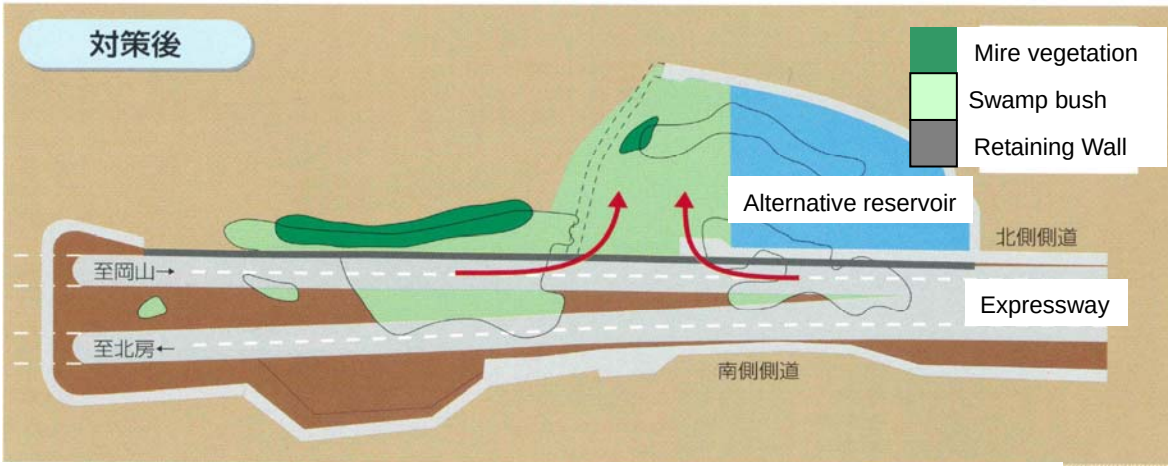

Fig.12 Picture of after transfer marsh

The area of the marsh was approximately 2.5ha. And the plan of construction of the Okayama Expressway was throughout there. The civic group in local had requested change of the method of construction. Then, a special committee examined would be able to change the method of construction. As a result, the installation of a construction road on the marsh side was stopped, the modification area of the marsh was minimized by retaining wall structure, a new marsh was maintained to the surroundings, and the valuable plant species were transplanted. (Figure.12)

The creation of marsh was cautioned not to lose environmental capabilities; covering soil with the downstream valley part, deforestation of the lower ground woods around marsh, and peripheral use of spring water, for example.

Moreover, the investigation of the volume and quality of water, the growth situation confirmation of flora and fauna were conducted. The operations of mowing were done effectively after the construction. It is transferring the area to Soja city now (Figure 13-14).

Fig.13-14 just after, and 15 years passed since transferred the marsh

As a result of measures, White egret flower (Pecteilis radiata) has increased than before construction, and new marsh valuable species such as “Kagashira” (Scleria caricina) and “Inusenburi” (Swertia tosaensis) that categorized into VU by red list of the Ministry of the Environment were newly confirmed. [3]

Moreover, to maintain not only a valuable plant but also the entire marsh ecosystem in this case, the preservation of insects around the marsh was considered, too. To reduce the influence of the nocturnal insects on the ecology that lived around the marsh area, the lighting of the tunnel pitheads of neighboring the marsh was selected from among eco-friendly products. The lamp in which insects don't gather easily and a wavelength band (450mm or more) that was longer than a center region of insects recognizes spectrum was adopted.

5. CREATION OF HABITAT

The first case is an introduction of the biotope created in the rest on Expressway as a case with the creation. It is Sanctuary of flora and fauna and the one that it locates and biotope was built in 1997 partially of the garden in the Fuchuko parking area on the Takamatsu Expressway that passes

Sakaide City.

An artificial pond was built in garden in the Fuchuko parking area as shown in Figure 16, and rainwater was made to circulate within the pump and the reeds and narrowleaf cattails were planted because of the water quality control and planted the pond with Japanese killifish (Oryzias latipes) that categorized into “Vulnerable” by red list of the Ministry of the Environment. The stone bank and miniature forest reserve were arranged around the pond for aquatic habitats to keep various conditions.

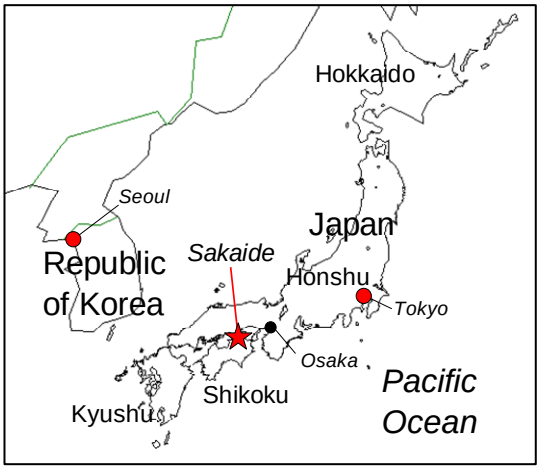

Fig.15 The location of Sakaide City

A lot of trees were planted around the pond and birds' biotope was secured. A sand beach for birds to was near the pond, and a Bird bath (Figure17) to bathe was in woods.

Fig.16 Artificial pond

Moreover, brushwoods stack (Figure 18) and stones stack that were constructed for reptiles and insects to habitat for various purposes.

In addition, this biotope has an educational function with view plaza to watch the biotope. And there is a signboard for drivers to understand effort of planning contents.

Fig.17 Bird bath

The brief and simple investigation [4] was done in October, 2008 that had passed 11 years after construction. As a result, fifty three species of in total living that were fourteen species of birds, one species of reptiles, one species of amphibians, one species of fishes, thirty three species of insects, and three species of benthos were confirmed. Some bird's wings were found on the birdbath. Therefore, investigators knew that the bird bath has been often used by birds. Moreover, there is a log-lay besides the brushwoods stack. The log-lay was used for insects to stay alive during winter in there.

Fig.18 Brushwoods stack

Administrators operate this field few times. Then, exotic plants such as Canada goldenrods (Solidago canadensis var. scabra) and growing thickly of the kudzu vines (Pueraria lobata) were found partly. Administrators keep the field fine; good environment for flora and fauna, and good landscape for drivers.

6. SUMMARY

Expressways in Japan are entered a transition from construction phase to management recently.

Evaluations of conditions on environment are like medical certificates, and the reports of investigates on environment are like prescriptions. Therefore, it is necessary to evaluate systematically after construction. And administrators have to maintain fields where were constructed by considering to natural environment.

There are many kinds of conditions on natural environment; such a weather conditions, soil conditions, aquatic environment, sunlight conditions, and flora and fauna aspects. Then these are unique conditions for each. Therefore, it is very difficult for administrators to restore same condition before construction even if they try to restore hard.

However, planners make efforts to minimize change of conditions on environment as possible. And they also make efforts to transfer of habitat. Then administrators will be able to maintain field on environment effectively. Planning before construction is the most important.

Investigates are also important. They are able to give planners (constructors / administrators) some feedback about evaluation reports. When planners accept these, they try to make much better plans than before read about reports.

7. APPENDIX

[1]In the district that the prefectural governor specified based on Natural Parks Low in Japan, and to maintain the scenic beauty of the park, the special district region is set. The permission of the prefectural administrator is necessary for the following acts. Building and rebuilding of structure, Cutting of trees, Collection of mineral, Getting water and drain of river, lakes and marshes, Notice of advertisement, Reclamation and reclamation of land, Capture and collection of flora and fauna, Change in painting color of facilities, Enter in specified district, Use of car in specified district.

[2] The Ministry of the Environment is providing the red list in Japan besides the red list of IUCN. The definition of IUCN and the definition of Japan are the same as the definition of the category.

[3] The Japanese ‘Eco-roads’ Guide（Japan Highway Landscape Association Aug. 2005）

[4]The purpose of the investigation done in Oct. 2008 is a watching to confirm the equipment of biotope and current state of vegetation investigation in the Fuchuko parking area. Therefore, the quadrate survey of the plant and the sweeping survey of the insect collection are not done.